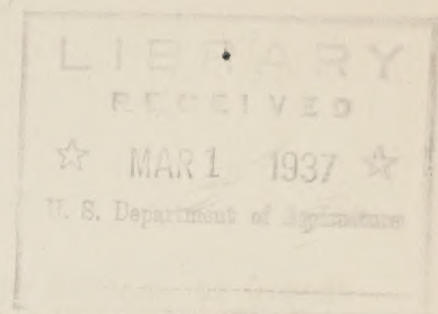


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CONTROL OF WIREWORMS ON IRRIGATED LANDS IN THE PACIFIC NORTHWEST

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Wireworms are considered to be among the worst pests of American agriculture. There are several different kinds that are especially injurious to crops grown in the irrigated districts of the Pacific Northwest. Wireworms in general are known by their hard, jointed bodies and more or less cylindrical, slender shape. They are usually dark yellow in color and range from three-eighth to seven-eighth of an inch in length. Almost their entire life of several years is spent beneath the surface of the soil. They damage crops by destroying seed, by cutting off small underground stems, and by boring holes in the larger stems, roots, and tubers. There is no cultivated crop known to be entirely immune from their attacks. The adult of the wireworm is a hard-shelled, brownish to black beetle approximately one-half inch long, commonly known as a click beetle or snap beetle. These beetles are the only stage of the wireworm to leave the soil, being active above the surface during the months of April, May, and June each year to mate, after which they enter the soil again to deposit their eggs. The life of a wireworm is from 2 to 5 years, depending on food and soil conditions, with an average of 3 years for most of them in the Pacific Northwest.

Intensive studies of the life history of wireworms and their behavior in the soil have resulted in the recommendation of several measures for their control. Two of these make use of chemicals--carbon disulphide and crude naphthalene--which act as fumigants to kill the wireworms in the soil, especially on smaller acreages or high-priced crops. The other control measures are based on cultural methods, which would obviate the expense of chemicals and consequently be of more practical use to the average farmer with a larger acreage. These cultural methods are based on the fact that great numbers of wireworms can be killed by producing either an excess or a deficiency of moisture in the soil during the summer season; that is, by flooding or by drying out the soil containing the wireworms. Since the majority of wireworms are to be found in the top foot of soil during the entire year, there are several cultural practices that will help to lessen their numbers or reduce their damage to a great extent.

Carbon disulphide. -- When carbon disulphide is used, the ground to be treated should be plowed deeply, smoothed lightly afterwards, and marked off in 2-foot squares. At the intersection of the marks, holes

should be punched with a stick to a depth of 3 or 4 inches. Then 1 fluid ounce of carbon disulphide should be poured in each hole and the hole immediately covered by pressing the soil down tightly with the foot. After 5 days the soil should be plowed deeply again and prepared for planting. One 100-pound (10-gallon) drum of carbon disulphide will treat approximately 5,000 square feet and will cost about \$8.50.

CAUTION: Liquid carbon disulphide evaporates very rapidly upon exposure to the air, and the vapor is extremely inflammable and explosive when mixed with air in certain proportions. It should therefore be kept in a cool place and handled with great care. Do not smoke when handling it.

Crude naphthalene. -- When crude naphthalene is used, it is recommended that the ground first be plowed as deeply as possible (10 to 12 inches) and the furrow slice be narrowed to about 9 inches. The flaked naphthalene, with the lumps reduced to the flake form, should be sprinkled by hand (or machine) along the sides of the furrow from top to bottom before being covered by the next furrow slice. Immediately after the plowing is finished, the entire field should be disked as deeply as possible in order to mix thoroughly the crude naphthalene crystals with the soil. This disking is very important, because the better the mixture of naphthalene with the soil the better will be the kill of wireworms. Smoothing the top soil with a float after disking will help to keep the naphthalene gas in the soil. It appears necessary to use 800 pounds of crude naphthalene per acre to obtain a maximum kill of wireworms. To insure an even distribution over the entire field the crude naphthalene should be weighed out at the rate of 1 pound to 73 linear feet of 9-inch furrow slice. After the expiration of a week the gas from the naphthalene will have accomplished its greatest kill of wireworms, and seed or sets can be planted with little risk of injury. There are no harmful residues left in the soil. The cost of naphthalene is from 3 to 5 cents per pound, depending on the distance from the source and the quantity to be purchased. At these rates it would cost \$24 for the material to treat an acre or about \$5 for enough to treat a small garden plot of about an eighth of an acre.

Carbon disulphide and crude naphthalene can be purchased through almost any seed store or growers' organization and both are manufactured on the Pacific Coast. It is important that the average temperature of the top foot of soil be as high as possible (at least 70° F.) during the period of treatment and that the soil be in good tillable condition, if the best diffusion of gas is to be obtained with either carbon disulphide or naphthalene. This practically limits the use of these materials in the Pacific Northwest to the months of May, June, July, and August.

Flooding. -- In the presence of excessive moisture, wireworms become inactive, and at low temperatures they can exist for months under water or in flooded soil. If the temperature of the water rises above 70° F., however, the wireworms will begin to die; and if this temperature

is maintained for a period of 5 to 7 days, a high percentage of them will be killed. These high temperatures are most likely to occur out-of-doors during July and August, when periods of hot sunny weather usually occur. The land infested with wireworms should be loosened by plowing, then leveled and diked at intervals, so that the water depth will not be over a few inches at any place. At about the time a period of hot weather is expected, a shallow layer of water should be turned into the diked areas and maintained for a period of a week. The temperatures of the soil under the water should be checked frequently, and if an average of 70° F. or higher is found at a depth of 6 inches for the period of flooding, a good kill of wireworms can be expected. Flooding kills all stages of wireworms, including the pupae and adult beetles. The principal drawback to this method of controlling wireworms is that it can be used only on fairly level fields when plenty of water is available for at least a week, and in fields not in crop during the period of flooding. It is especially adapted to reduction of the number of wireworms in gardens and in the more intensive truck-gardening sections, where the land is generally fallow in the summer for a short period between the spring and fall crops.

Drying. -- Another method of killing large numbers of wireworms is to allow the top 18 inches of soil to become very dry for several weeks during the summer. Wireworms cannot survive in soils that become dust-dry or are too dry to support shallow-rooted plants. In order to accomplish this drying of soil, deep-rooted crops such as alfalfa and fall grains must be grown without any irrigation during the entire season. In fact, the late fall irrigation of alfalfa should be withheld the year previous to this treatment to help reduce the moisture content of the top soil as much as possible. Apparently the wireworms cannot escape from the upper dry soil layers by downward migration. In soils of the loam types where there is no subirrigation, or where the water table is not too near the surface throughout the season, this soil-drying treatment should reduce wireworm numbers sufficiently so that potatoes and other susceptible crops can be grown the following season in these fields with little damage from the wireworms. This method also fits in with the regular rotations usually followed in the Pacific Northwest. The farmer will have to plan on a reduction in his yield of alfalfa or grain, but he should be able to harvest a partial crop if the normal spring rainfall is received. The ground should not be disturbed before the first of September, after which time the land could be fall-plowed and prepared for growing truck crops the following season. If this drying-out process can be fitted into the rotation so that any field likely to be badly infested with wireworms is dried out once every fifth or sixth year, the wireworm population will be kept to a minimum and little damage to crops will occur.

These recommendations for flooding and drying out soil to control wireworms should be adapted to the individual conditions of the particular field to be treated. Small plots that are heavily infested can be flooded for a short period in summer and the wireworms practically eliminated. On the other hand, large areas not adaptable to flooding can be

dried out, although this method means that the crop yield will be greatly reduced because of the lack of water.

Summer plowing. -- Plowing of fields in the hot summer months after early crops have been removed also helps to kill the pupal stage of the wireworms. This is a particularly delicate stage when the wireworms are changing to beetles in the soil. Plowing to a depth of 9 inches around the first of August and allowing the dry lumpy soil to lie undisturbed for a few weeks will cut down materially the numbers of beetles that might emerge and lay eggs the following spring.

Rotations. -- The relation of crop rotations to wireworm numbers and damage has been studied now over a period of six seasons. It has been found that red clover and sweetclover have a tendency to increase wireworm numbers materially after 1 or 2 years. Just why this is so is not fully understood, but if wireworms are known to be present it is not advisable to grow these crops before planting truck crops that might be damaged severely by wireworms. On the other hand, alfalfa does not seem to cause an increase in wireworm numbers in most situations and it has a tendency to reduce heavy infestations after five or six years. Pasture-sod conditions also appear to be detrimental to wireworm increase if maintained for several years.

At present the crude-naphthalene treatment, summer flooding, drying out the soil by growing grain or alfalfa, and summer plowing are the best measures recommended for reducing wireworm numbers under the various conditions in which they are troublesome. In conclusion it might be stated that none of these controls for wireworms is an every-year treatment. The long life cycle of the wireworms and the fact that reinfestations occur only by deposition of eggs in the spring by the adult beetles preclude their increase to damaging numbers in less than 2 or 3 years. Under weather or soil conditions in the spring which are unfavorable for the deposition of eggs the period might be even longer between necessary control treatments.